



Translation of Japan Patent – JP 06-206734 Kohei et al.

(54) Invention Title: Manufacturing Method of Optical Fiber and Its Apparatus

(57) Abstract:

[Objective]

The objective of the invention is to provide an optical fiber manufacturing method and its manufacturing apparatus for easily controlling fiber diameter and fiber drawing speed, and largely shortening the time of raising the fiber drawing speed during the drawing a large size optical fiber preform.

[Construction]

An optical fiber preform 11 is heated and melted and drawn in a wire-drawing furnace 12 with a heater head, then a coated layer is applied to the surface of the optical fiber 13, finally the optical fiber is wound. This kind of optical fiber manufacturing apparatus has a first optical fiber outer diameter measurement device 14 for measuring the outer diameter of the drawn optical fiber 11 [*Translator's Remark: "11" should read "13"*] to control a drawing speed according to the measured diameter, and a second outer diameter measurement device 21 above the entrance of the first diameter measurement device 14 for measuring the optical fiber outer diameter during the period before the drawing speed of the optical fiber 13 reaches a predetermined drawing speed (100 m/min above).

[Claims]

[Claim 1] An optical fiber manufacturing method of drawing optical fiber preform heated and melted in a wire-drawing furnace has its feature: at a drawing speed rising period, the outer diameter of the optical fiber is measured by a wide-sight outer-diameter measurement device located between the wire-drawing furnace and a narrow-sight outer diameter measurement device for the fiber diameter control to measure the optical fiber outer diameter, and at the time after a stable fiber drawing speed is reached, the method switches to using the narrow-sight measurement device to measure the optical fiber outer diameter.

[Claim 2] The method as claimed in Claim 1, wherein the stable fiber drawing speed of the optical fiber manufacturing method feature is a predetermined speed above 100 m/min.

[Claim 3] An optical fiber manufacturing apparatus comprising drawing heated and melted optical fiber preform in a wire-drawing furnace with heater head, then coating the surface of the optical fiber, and rolling the optical fiber, the feature of the optical fiber manufacturing apparatus is to set a second outer diameter measurement device for measuring the outer diameter of the drawn optical fiber before the optical fiber drawing speed reaches a predetermined drawing speed, which is located in entrance side of a first outer diameter measurement device to measure optical fiber outer diameter and to control the fiber drawing speed according to the diameter measurement.

[Claim 4] The apparatus as claimed in Claim 3, wherein the measurement sight and precision of the second outer-diameter measurement device of the feature has a wider measurement range, comparing with the measurement sight and precision of the first outer-diameter measurement device.

[Specification of the Invention]

[0001]

[Industrial Application Area (Field of the Invention)] The present invention relates to a method and a apparatus of manufacturing optical fiber to easily control fiber diameter and fiber drawing speed, and to largely shorten the fiber drawing speed rising time.

[0002]

[Prior Art (Related Background Art)] In general, optical fiber manufacturing uses the optical fiber manufacturing apparatus, draws optical fiber from the optical fiber preform, coats the fiber, takes the tensile strength test, and finally rolls the fiber on a reel.

[0003] Figure 2 shows a conventional optical fiber manufacturing apparatus. In the figure, the manufacturing apparatus 10 has a wire-drawing furnace 12 for drawing fiber from the optical fiber preform 11, an outer-diameter measurement device 14 for measuring the outer diameter of the drawn optical fiber 13, a first coating section 15 consisting of die 15a and curing oven 15b for applying a first coating layer on the outside

of the optical fiber 13, a second coating section 16 consisting of die 16a and curing oven 16b for applying a second coating layer, a screening section 7 for giving a certain tension to the optical fiber 13 and testing the tensile strength, and reel 18 for rolling the optical fiber 13.

[0004] [Problems to Be Solved by the Invention]

The optical fiber manufacturing needs to heat and draw the optical fiber preform, to measure bare optical fiber outer diameter by an outer diameter measurement device, and to control a fiber drawing speed of a capstan such that the bare optical fiber has a certain outer diameter. However, to execute a high speed fiber drawing from a large preform has the following problems.

[0005] A) If not to locate the outer diameter measurement device 14 for the fiber diameter control at a location of 1-2 m directly below the conventional wire-drawing furnace, the high speed fiber drawing and the fiber diameter precision control within $125 \pm 0.3 \mu\text{m}$ can not be maintained.

B) If to locate the outer diameter measurement device 14 for the fiber diameter control at a location of 1-2 m directly below the conventional wire-drawing furnace, the optical fiber vibration happens before the fiber drawing speed reaches 100 m/min. It results vibration amplitude of $\pm 10 \text{ mm}$ near the entrance of the outer diameter measurement device 14, thus the diameter control and the drawing speed control become difficult. It makes problems of costing time and so on for raising the fiber drawing speed.

[0006] In view of the above problems, the objective of the invention is to invent a manufacturing method and a manufacturing apparatus that can easily control the fiber diameter and the fiber drawing speed, and largely shorten the time for raising the fiber drawing speed, even in the case of drawing the fiber from a large optical fiber preform.

[0007] [Means for Solving the Subject]:

The invention method of the optical fiber manufacturing to achieve said objective is a manufacturing method which draws the optical fiber from the heated and melted optical fiber preform in a wire-drawing furnace; the feature of said method is that: at a drawing speed rising period of the optical fiber which is out from the wire-drawing furnace and in the measurement sight, the method uses a wide-sight measurement device located

between the wire-drawing furnace and a narrow-sight outer diameter measurement device for the fiber diameter control to measure the optical fiber outer diameter, and at the time after a stable fiber drawing speed is reached, the method switches to using the narrow-sight measurement device to measure the optical fiber outer diameter.

[0008] On the other hand, the optical fiber manufacturing apparatus of the invention is an apparatus to draw optical fiber from the optical fiber preform which is heated and melted in the wire-drawing furnace with the heater head, to coat the optical fiber surface, and to wind the optical fiber. The feature is to set a second outer diameter measurement device to measure the optical fiber outer diameter before the optical fiber drawing speed reaches a predetermined speed, located above the first outer diameter measurement device which measures the optical fiber outer diameter for control of the fiber drawing speed.

[0009]

[Embodiment, example] Hereafter, a preferred embodiment is described by referring to the drawings. Figure 1 is a schematic figure of the optical fiber manufacturing of this embodiment.

[0010] As shown in the figure, the optical fiber manufacture apparatus 20 comprises the followings: a wire-drawing furnace 12 for drawing the fiber from the optical fiber preform 11; a first outer-diameter measurement device 14 for measuring the drawn optical fiber 13; a first coating device 15 consisting of a die 15a and a curing oven 15b for applying a first coating layer on the surface of the optical fiber; a second coating device 16 consisting of a die 16a and a curing oven 16b for applying a second coating layer; a screening section 17 for giving a certain tension to the optical fiber and testing tensile strength; and a reel 18 for winding the optical fiber 13.

[0011] In this embodiment, the second outer-diameter measurement device 21, which is for measuring the outer-diameter of the optical fiber 13 before the fiber drawing speed reaches a predetermined speed, is set near the outlet of the optical fiber 13 from the wire-drawing furnace 12 and above entrance of a conventional first outer-diameter measurement device 14.

[0012] The above mentioned first outer-diameter measurement device 14 is the same as

usual, and is normally monitoring the optical fiber outer diameter under a stable status when the fiber drawing speed reaches the predetermined speed for the fiber drawing speed control according to the outer diameter measurement. The measurement sight of the first outer-diameter measurement device is generally a narrow range of 1x2 (mm) or 2x2 (mm), however, its measurement accuracy is $\pm 0.3\mu\text{m}$ and takes a high precision.

[0013] On the other hand, the second outer-diameter measurement device 21 is used for measuring the optical fiber outer diameter at the beginning period of the fiber drawing until its drawing speed reaches the predetermined speed. The measurement sight of this second outer-diameter measurement device 21 is a wide range of 5x30 (mm) or 12x12 (mm) and its measurement accuracy is $\pm 5\mu\text{m}$ and takes a relatively low precision.

[0014] Next is a description of an example of the optical fiber manufacture using a large size optical fiber preform. The large size optical fiber preform 11 is installed in the wire-drawing furnace 12, and heated and melted, and the fiber drawing is started and the fiber drawing speed is slowly increased. During the period of the fiber drawing speed increase, this second outer diameter measurement device 21 is used to measure the outer diameter of the optical fiber 13. When the fiber drawing speed reaches the predetermined speed (e.g., 100 m/min above), the first outer diameter measurement device 21 [Translator's Remark: device "21" should read device "14"] is used for measurement as same as usual.

[0015] Thus, in the drawing beginning period of the drawing speed rising and at the stable period of the drawing speed, the different outer diameter measurement devices with different measurement sights and measurement precisions are used respectively. During the period of the drawing speed rising and low, even the optical fiber vibration amplitude ($\pm 4\text{ mm}$) happens, the outer diameter measurement can be taken because of the wide measurement sight, and the fiber drawing speed control can be performed. As a result, the fiber drawing speed rising time can be shortened largely.

[0016] A conventional method is shown in Figure 2. At the location of 1-2 m directly below the wire-drawing furnace, near the entrance of the first outer diameter measurement device 14, the optical fiber vibration amplitude reaches $\pm 10\text{ mm}$, and it makes the optical fiber diameter control and the fiber drawing speed control extremely

difficult, and the drawing speed rising time increased largely. As the method, to use two types of outer diameter measurement devices solves this problem. As a result, to reach a stable fiber drawing speed (100 m/min) takes about 2 hours by the previous method. In this example, it shortens about 30 minutes, i.e., about 1/4 time.

[0017] Furthermore, the optical fiber drawn for about 2 hours by the previous method can not be used. Now, the usable efficiency of the drawn optical fiber preform of 30 minutes is raised.

[0018]

[Effect of the Invention] As described in the above example, if to use the invention, even in using a large-size optical fiber preform, the fiber diameter control and the drawing speed control become easier, and the time for raising the drawing speed to the stable speed is largely shortened, the time loss and the optical fiber preform loss can be controlled in a minimum range.